Space Weather Technical Forecast

Issued on Tuesday, 25 April 2023 at 13:26 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

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Space Weather Forecast Headline: Waning CME effects with G1/Minor Storm risk Day 1 (25 Apr), further CME possible Day 3 (27 Apr) with G1/Minor-G2/Moderate Storm risk. Slight chance of M-class flares (R1-R2 Minor-Moderate radio blackouts) throughout. Chance of Active fluence.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has been Low over the past 24 hours, with frequent minor C-class flares observed. There are currently eight sunspot regions on the visible disc. AR3282 approaching the northwest limb is the largest region but is no longer fully visible, so the current classification will be maintained as it rotates off. AR3285 in the southeast is the second largest region and remains generally stable, with its trailing spots weakening. AR3288 in the southeast has developed quickly and is showing signs of increasing magnetic complexity, further development of this region will be closely monitored. The remaining sunspot regions are all generally small and simple.

A filament eruption occurred from near south centre disc, starting around 24/1300 UTC. The CME has been observed in coronagraph imagery heading mostly south, but an Earth directed component is likely, with this potentially reaching Earth early on 27 April.

Solar Wind / Geomagnetic Activity: The solar wind, as observed by DSCOVR at L1, continues to show the influence of a CME arrival at 23/1700 UTC. After a brief period of strong winds, the wind speed has been predominantly at elevated levels. The solar wind is currently around 520 km/s and is showing slow and steady decline. The density has been predominantly average, with a peak of 20ppcc 24/1252-1332 UTC. The IMF was initially strong with a peak of 29nT observed at 24/1200 UTC. IMF then gradually declined to moderate levels and has been weak since 25/0030 UTC. The north-south component (Bz) was strongly positive initially, with a maximum of 24nT observed at 24/1509 UTC. It is now weakly positive, fluctuating between positive and negative. The phi angle was mostly negative (towards the Sun), but has been mostly positive (away from the Sun) since 25/0247 UTC. Geomagnetic activity started the period at Active levels, but gradually eased and is now at Quiet to Unsettled levels.

Energetic Particles / Solar Radiation: High energy proton flux (greater than 10MeV) has been at background levels throughout. High energy electron flux (greater than 2MeV) as measured at GOES16, has persisted at predominantly moderate levels. The associated 24-hour electron fluence was below the Active threshold on a rising trend, with 9.43e6 integrated pfu observed at 25/0000UTC.

Four-Day Space Weather Forecast Summary

Solar Activity: Solar activity is most likely to remain Low, with a slight chance of becoming Moderate.

Solar Wind / Geomagnetic Activity: Earth is currently experiencing impacts from the CME which left the Sun on 21 Apr, with solar winds currently at elevated levels. Another filament eruption occurred from near south centre disc on 24 Apr. An Earth directed component is

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probable, potentially reaching Earth either late on Day 2 (26 April), but more likely early on Day 3 (27 April). Solar winds are likely to gradually ease through Day 1 (25 Apr) as the current CME effects wane. A HSS from CH96/- is likely to arrive during Day 2 with wind speeds reaching up to 550-600 km/s.

Geomagnetic activity is currently Quiet to Unsettled (Kp 0-2), but there is a slight chance of a further G1/Minor Storm interval on Day 1 if the magnetic field rotates to a southward orientation. Activity is then expected to remain Quiet to Unsettled until the potential HSS/CME arrivals later Day 2 or early Day 3, when activity is likely to become Active to G1/Minor Storm, with a slight chance of G2/Moderate Storm intervals on Day 3. Activity returning to Quiet or Unsettled during Day 4 (28 Apr).

Energetic Particles / Solar Radiation: High energy (greater than 10MeV) proton flux is most likely to persist at background levels, although there is a slight chance of S1 or greater, either due to the recent filament eruption or any significant flares. High energy (greater than 2MeV) electron flux is currently at moderate levels, with a rise possible through Days 1 and 2 (25-26 Apr), before a probable decline through Days 3 and 4 (27-28 Apr). Electron fluence is likely to rise at first, with a chance of reaching Active (1e8 integrated pfu), before probably declining again by Day 3 (27 Apr).

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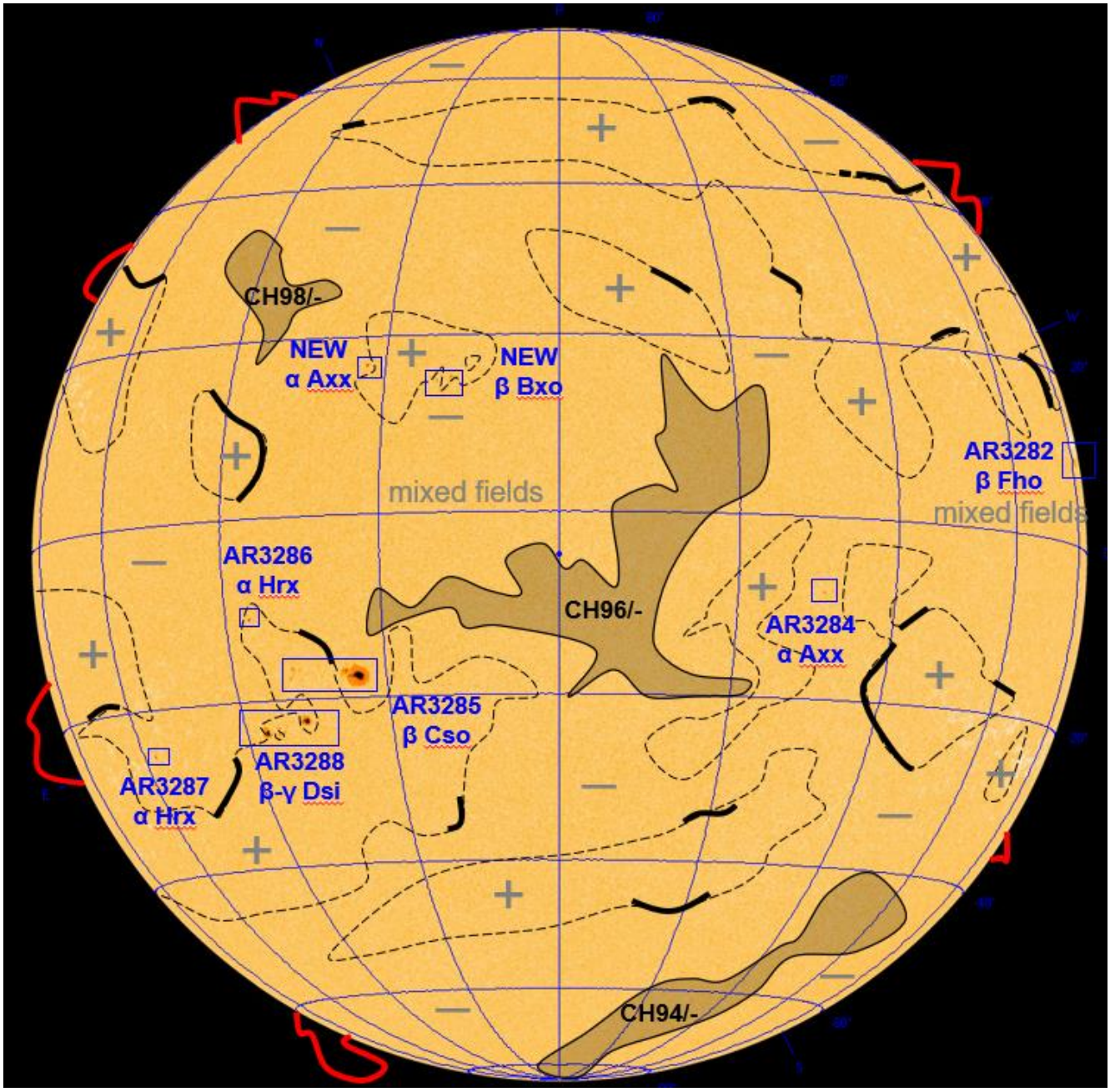
Figure 1. Solar Analysis Valid 25/0800.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Met Office Space Weather Technical Forecast

Geomagnetic Storms:
Earth is continuing to experience effects of the full halo CME which left the Sun on 21 Apr, with solar winds currently at elevated levels. However, the effects are waning and wind speeds are on a gradual decline.

Another filament eruption occurred from near south centre disc, starting around 24/1300 UTC. The CME has been observed in coronagraph imagery heading mostly south, but an Earth directed component is probable, with this potentially reaching Earth early on Day 3 (27 April). Although arrival time estimates have varied between late on the Day 2 (26 April) and early on Day 3, the most probable arrival time is during the UTC morning of Day 3.

Solar winds are likely to continue to gradually ease through Day 1 (25 Apr) as the current CME effects wane, falling to slightly elevated levels. A HSS from CH96/- is likely to arrive during Day 2, similar to persistence and supported by SWFM. The leading edge of this feature is similar to the last rotation, however, it is a broader and better defined feature than last time, forecast wind speeds of around 550-600 km/s are reasonable and consistent with thinking. The strength of the winds in the HSS may be somewhat superseded or masked by the possible arrival of the CME from 24 April.

Geomagnetic activity is currently Quiet, with Quiet to Unsettled activity likely to prevail for much of Days 1-2. There remains a slight chance of an isolated G1/Minor Storm interval if the magnetic field rotates to a southward orientation, mainly when Earth exits the CME influence on Day 1. However, this is low confidence.

The HSS and preceding CIR from CH96/- later on Day 2 are likely to be reflected in an increase in geomagnetic activity, with Unsettled or Active intervals (Kp3-4) likely, and a Slight Chance of G1/Minor Storms (Kp 5). The anticipated arrival of a glancing blow from a CME during Day 3 in combination with the HSS, increases the probability of experiencing elevated geomagnetic activity, with G1/Minor Storm conditions likely and a slight chance of a G2/Moderate Storm (Kp 6).

In the absence of further CMEs, activity is expected to wane during Day 4 (28 Apr), returning to Quiet or Unsettled levels.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	**G1 to G2**	No	10	20	50	10
Strong	**G3**	No	1	1	5	1
Severe	**G4**	No	1	1	1	1
Extreme	**G5**	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
24/1900	Partial	Filament Eruption	SW	700 km/s	27/0300	Glancing blow probable.

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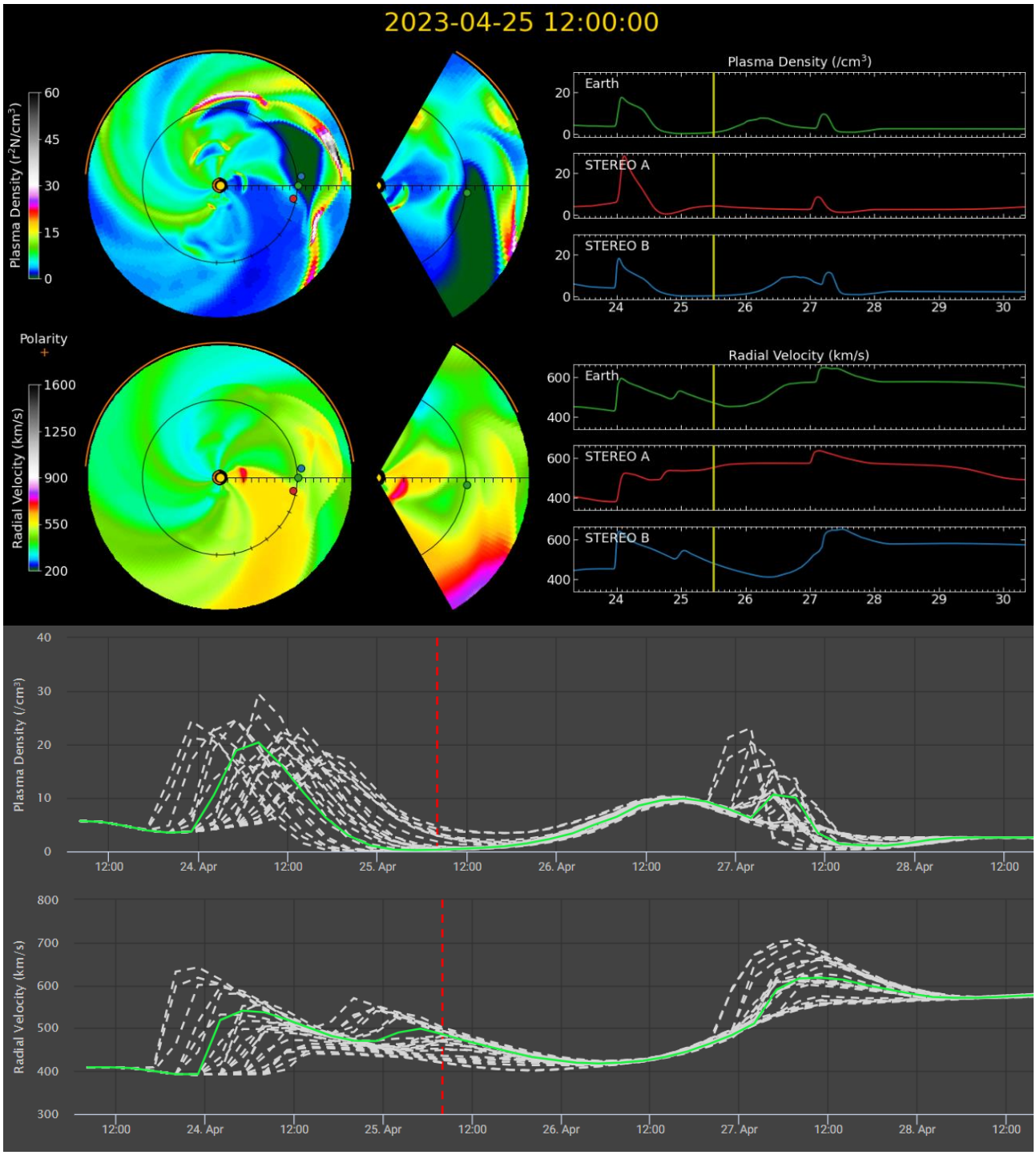
Figure 2: MOSWOC Enlil and ensemble showing the probable CME glancing blow on 27 April, with the bulk of the ejecta expected to pass below Earth's orbit



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Radio Blackouts - X-Ray Flares:
There are currently six numbered sunspot regions and two unnumbered regions on the visible disc.

AR3282 remains the largest region, but will soon have rotated across the western limb. As it is no longer wholly visible, the current classification will be maintained. AR3285 in the southeast is the second largest and remains generally stable, however, recent fading of its trailing spots has seen it reclassified as Cso/Beta. Newly numbered AR3288 region which developed quickly to the southeast of AR3285 has now been classified as a Dsi/Beta-Gamma. Further development of this region is anticipated and will be closely monitored as it is already producing minor flares. The remaining sunspot regions are all generally small and simple, including two newly emerged regions in the northeast.

Far side imagery indicates some weakly active regions could rotate across the eastern limb during the period, with a possible increase in flare risk. However, until these regions emerge, any increase in flare risk cannot be accurately assessed. Overall solar activity is likely to remain Low, with a slight chance of becoming Moderate with any isolated M-class flares.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	No	15	15	15	15
Very Active	R3 to R5 X Class	No	1	1	1	1

Figure 3: SDO intensitygram and magnetogram, showing AR3285 with developing AR3288 region to its southeast.

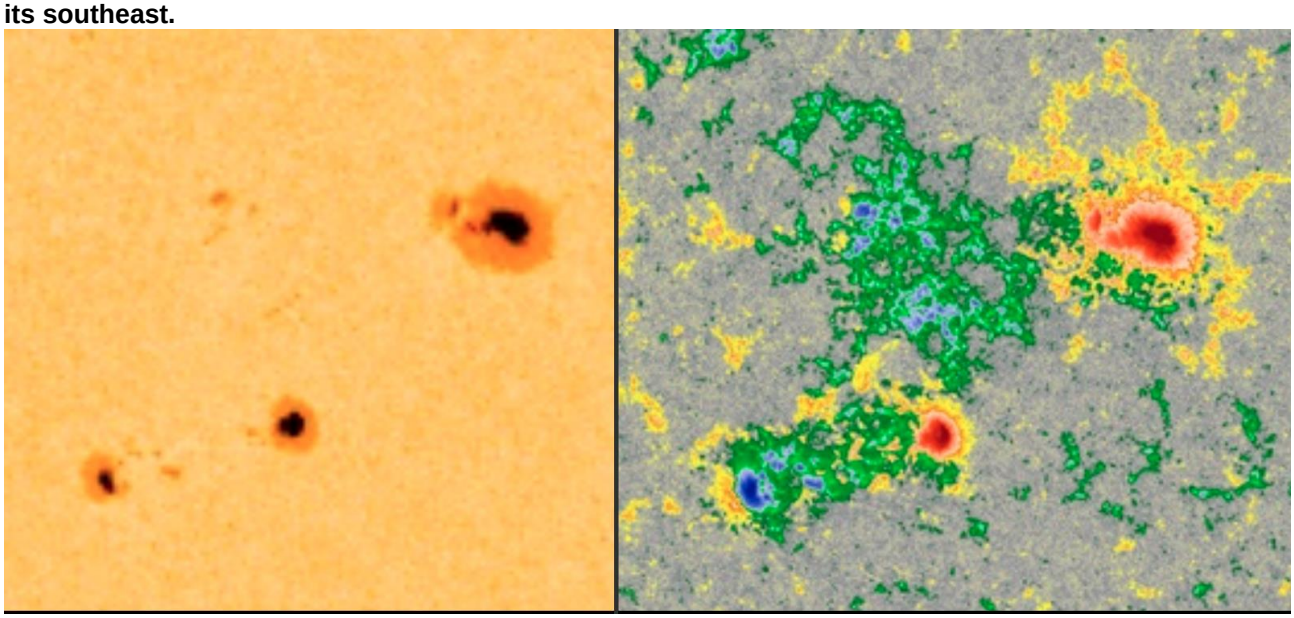

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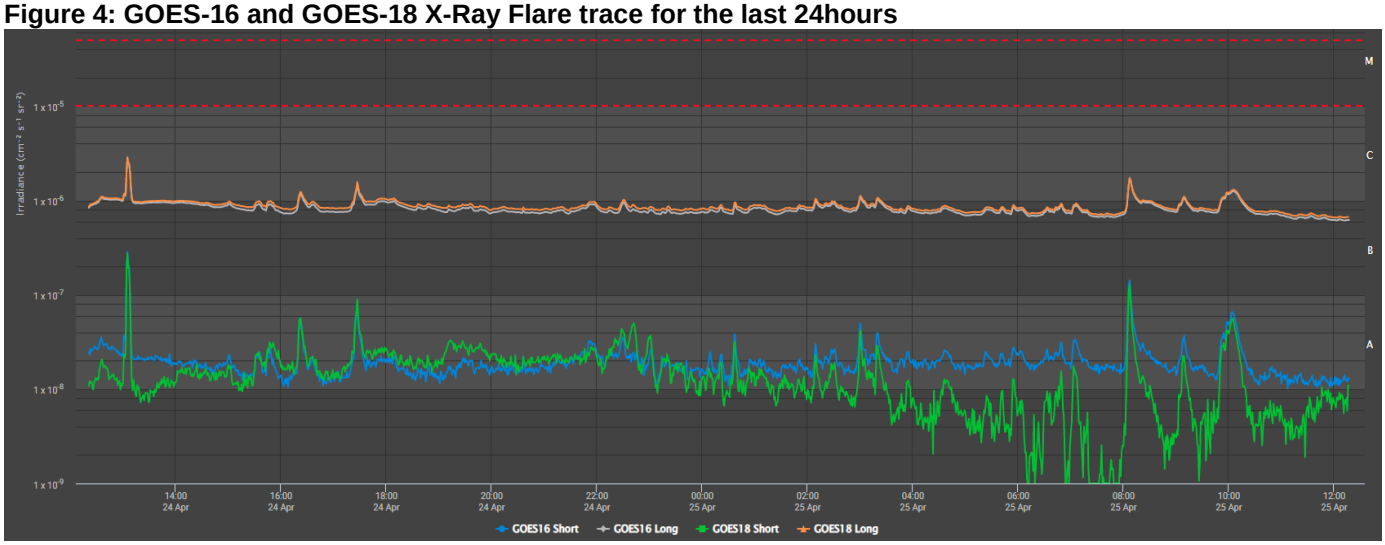
Figure 4: GOES-16 and GOES-18 X-Ray Flare trace for the last 24hours



Solar Radiation Storms - (High Energy Protons):
High energy proton flux (greater than 10MeV) is currently at background levels. There remains a slight chance of reaching the S1/Minor Storm level, either from effects of the filament eruption on 24 Apr, but mainly due to AR3282 as it rotates off of the visible disc. Probabilities expected to fall further by Day 4 (28 Apr) as AR3282 rotates well away from the western limb.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	5	5	5	3
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

High Energy Electrons Event (≥ 2MeV):
High energy (greater than 2MeV) electron flux remains at moderate levels. The BAS radiation belt model suggests that electron density has increased in the radiation belt from the recent CME effects. As wind speeds ease during Day 1 (25 Apr), it is likely that the radiation belt will relax towards GEO, carrying the increased density and causing an increase in electron flux at GOES-16. However, the arrival of a HSS and further possible CME (see Geomagnetic Storm section) from Day 2 into Day 3 (26-27 Apr) is then likely to suppress levels once more. Flux may reach moderate to high levels at the diurnal peak during Days 1-2 after which time, it is more likely to remain at lower levels.

The associated 24-hour integrated fluence is expected to continue to show a rising trend through Days 1 and 2, with a chance of reaching Active (1e8 integrated pfu), followed by a decline through Days 3 and 4 (27-28 Apr). MOSWOC REFM is suggesting a rise to just below Active, which is a reasonable steer at first, however, it does not take into account the arrival of a HSS/CME during Days 2 or 3.

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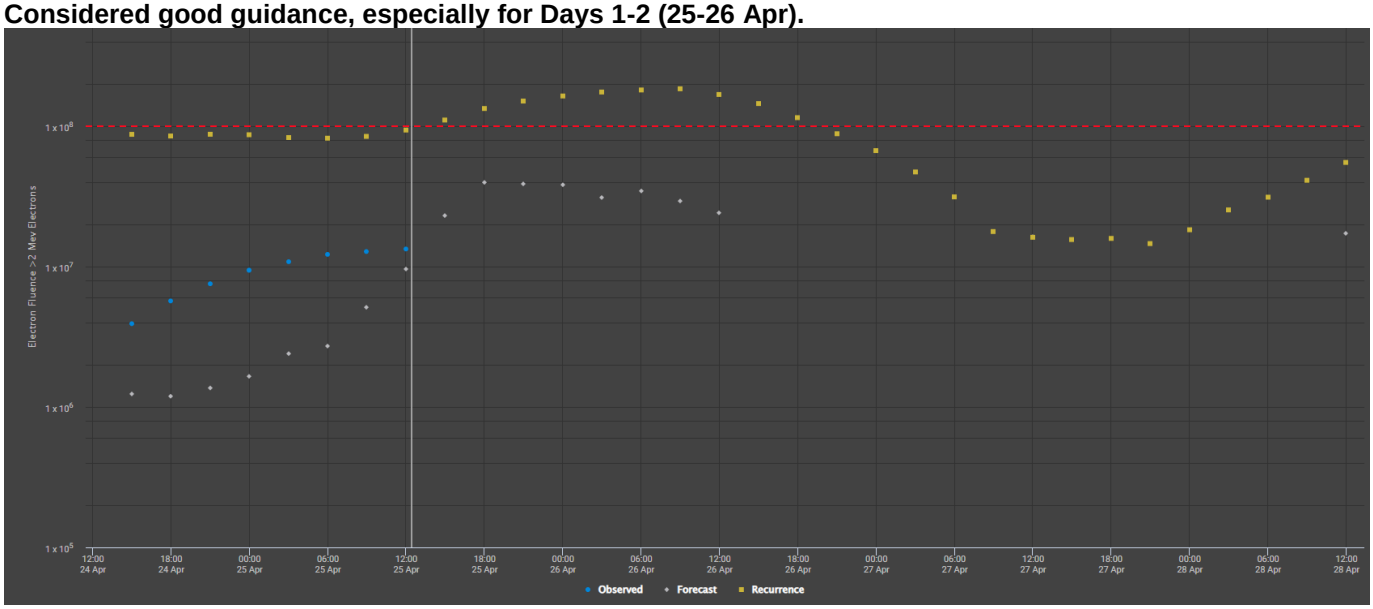
GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	No	30	50	30	20
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

Figure 5: MOSWOC REFM forecasting an increase below Active (1e8 integrated pfu) which is Considered good guidance, especially for Days 1-2 (25-26 Apr).



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